

PFEA Water Quality Map

Design Report

Final Draft | Due Dec 11, 2017



Waterkeepers

Lauren Choy, Anay Jain, San Kang, Oscar Lai
Alex Lee, Ellis Lee, Kevin Liu, Sharmaine Manalo



In collaboration with **PFEA**

Margarita Diaz
Director of PFEA

UC San Diego

University of California, San Diego
ENG 100D FALL 2017 | Brandon Reynante

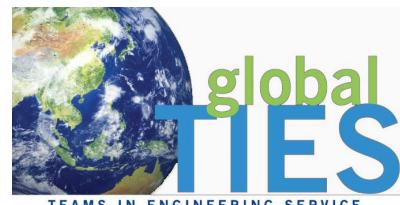


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Executive Summary

The main objective of our project is to raise awareness of the poor water quality of public beaches in the Tijuana area. Alongside our partner organization, we have developed a dynamic water quality map of Tijuana, in the form of a web application. This web app was created in hopes that it will help inform and protect the public by showing them the margins of safety at various beaches in Tijuana.

Our partner organization is Proyecto Fronterizo de Educación Ambiental. PFEA is one of 300 waterkeepers around the world, and their mission is “to protect the ocean, streams and coasts of our watershed.” Our main client from PFEA is Margarita Diaz, one of the co-founders of the organization. She is solely responsible for the idea of creating a water quality map of Tijuana. She states that “every person should have the right to know and the right to health,” and she believes that this project is the unity of these two rights. She has pitched this idea to the Mexican government before, presenting statistical evidence, but they ultimately shut her down. When approached by Brandon Reynante and Global Ties, she saw it as the perfect opportunity to finally make her dream a reality.

This project targets users within the Tijuana area who may come into contact with the larger bodies of water. They need to be able to easily access the information necessary to protect themselves from contaminated waters. Through our interviews and secondary research, we found that one of the biggest issues was the societal norm that the water in Tijuana has always been seen as dirty. The people of Tijuana have stopped seeing this as an issue, and have accepted it as a factor of life. To them, the damage is irreversible. Lack of proper plumbing and disposal in rural areas strongly contribute to the high bacteria levels in the water. This, combined with massive industrialization and urbanization of the area, has led to increases in debris flowing into the rivers and ultimately ending up in the ocean. The damage is severe, but extreme change in waste management can aid the issue.

Utilizing human-centered design, we approached this challenge with an emphasis on desirability, usability and accessibility. The primary goal is to get people to use this application, thus, we prioritized desirability. Usability plays a large role in desirability, as people will not want to use an app that does not function in an intuitive manner. Finally, accessibility is key in allowing our users to find the desired information under any circumstances. These three concepts were kept in mind throughout our design process.

After assessing all of our concepts and prototypes, we approached the final design with a simple aesthetic that provides instant information to our users. From testing, we found that users want a quick interaction to access information. We utilized colored location pins and a legend to visually represent the different levels of bacteria at each site, we have achieved this. Our sites are geographically labeled on the map, so it matches the user’s mental map. Finally, our application scales for desktop and mobile phone use, allowing users to access the information from anywhere with internet access. We hope that this tool will help encourage people to practice healthy beach habits.

1. Project Management

1.1 Motivation & Goals

Our partner organization, Proyecto Fronterizo de Educación Ambiental (PFEA) believes every person should have the right to know and the right to health. This project is the unity of those two rights, utilizing information and knowledge to protect the health of the public. As the Director of PFEA, Margarita said, "Information is power. You have to give to everybody. If you keep it, it's not right." People in Tijuana, visiting or residing, do not see the city as an ocean city, rather, they see it as just a border or drug city, and the ocean becomes an afterthought. However, now that PFEA has raised awareness of Tijuana's coastal areas, they are having problems with the quality of water. The water quality changes drastically week to week, ranging from 200 to 7,000 bacteria, whereas 100 bacteria is what we consider safe in the United States. PFEA has been monitoring the quality of water on a weekly-basis by sending professionals to each major body of water to record the bacteria levels, but there is no way of distributing this information. Margarita and PFEA have approached the Mexican government regarding this issue, but they refuse to publish the information for fear of public backlash. In light of this, our goal is to help PFEA implement a web application for beachgoers in Tijuana to easily access the information necessary for their safety.

1.2 Approach & Schedule

Our team will implement a human-centered design process to create our web application. We will first conduct secondary research and interview our stakeholders to find their needs. Our partner organization has stressed to us the importance of building upon our predecessor's work, as it is inefficient to build from scratch. We will compare their work with other similar applications, such as Swim Guide and more popular map applications like Google Maps. This comparative analysis will ensure that our product is distinctly intuitive and user-friendly. We plan to start by improving on the previous group's design and then implementing the app so that it is fully functional (Figure 1.2.2). Our partner organization has made it clear that they want to see a finished product before releasing it on their domain.

We met with partner organization in October and actively listened to each of their suggestions. We made sure to keep in mind that our template must be dynamic so that the content can be easily adjusted to the changing water quality. Moreover, we had Skype calls with our partner organization to show them the progress of our designs and get feedback. Initially we had planned to meet with Margarita and the water testers in Tijuana, but plans fell through and we were unable to visit the grounds.

Our first step in our project is empathizing. Starting with secondary research and interviews with stakeholders, we want to scope our design challenge and target user needs. This needfinding includes studying the background of the issue as a whole, understanding the culture, and integrating this knowledge with our design challenge. After needfinding, we will be ideating to come up with as many ideas as possible to improve or implement a program. When ideating, we will have to think about feasibility and implementation. After ideation, we have to make sure our ideas match our scope, regarding feasibility.

The next task is developing several prototypes of a few design concepts and test them to see what works and what fails. We will create wireframes that will be made interactive on Invision, and observe participants while they are using our prototype. We will be looking for good user flow, low probability of running into errors, and clarity of content. From this, we hope to find

deeply-ingrained user needs, as far as our application goes. After they have used our prototypes, we will ask them several questions regarding usability and understanding. This will give us a comparable understanding of our prototypes.

The final step of our project will be the actual implementation of our web application. We will first need to take in the feedback from our testing phase and improve upon our prototype designs. Then, we will need to code a fully-functional, dynamic water quality map. This map should serve as a visual database that will communicate knowledge to the public. After the basis has been implemented, we will need to introduce the map to our partner organization and a sample of our target audience to gain further feedback and help us discover any bugs. Finally, we will need to teach PFEA how to update the excel sheets with up-to-date water quality information.

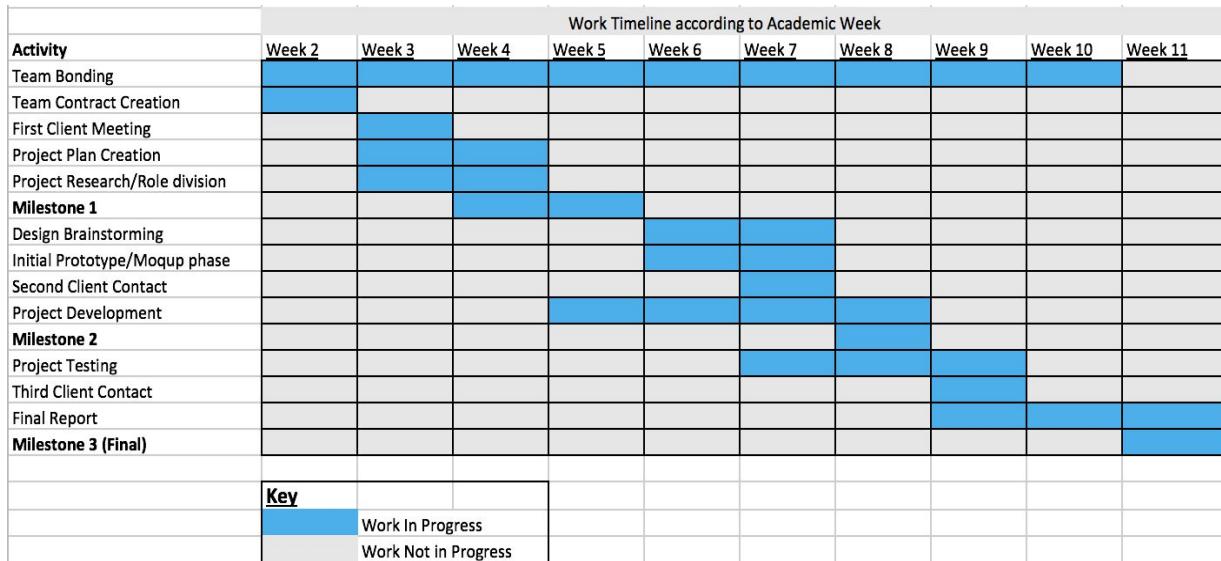
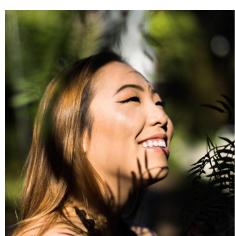


Figure 1.2.1 - *Gantt Chart*

1.3 Team Bios



Name: Ellis Lee
Contact Info: esl037@ucsd.edu
Role: Team Leader & Front-End Developer
Responsibilities: Ellis is responsible for initiating team communication and productivity. As a UX/UI designer, she will ensure the application is intuitive and user-friendly.
Experience: Ellis is a third-year Human-Computer Interaction and Design student with a passion for UX/UI research. As a College Ambassador, she has developed strong communication and leadership skills that she plans on bringing to the team. She has experience in Sketch, HTML/CSS, and Adobe Illustrator.



Name: Alex Lee
Contact Info: aml023@ucsd.edu
Role: Front-End Developer
Responsibilities: Alex is responsible ensuring a quality user experience through the project design. He will help maintain functionality of the app and help with designing graphics.
Experience: Alex is a senior Human-Computer Interaction and Design student with an interest in User Experience and Interfacing. He has experience with Adobe Creative Suite programs such as Photoshop, Illustrator, and InDesign, as well as some coding experience with HTML/CSS. He has a strong background of working in teams.



Name: Lauren Choy

Contact Info: lmchoy@ucsd.edu

Role: Front-End Developer

Responsibilities: Lauren is responsible for aiding with the information architecture and user experience of the project design. More specifically she will test for usability and cohesion of the site.

Experience: Lauren is a third year Human-Computer Interaction student. She has experience with wireframing, prototyping and usability testing. She is well versed in prototyping through the use of the program Sketch.



Name: Anay Jain

Contact Info: anj023@ucsd.edu

Role: Front-end Developer

Responsibilities: Anay is responsible for helping create a viable user interface and maintaining effective communication with the client to ensure that they are on board with every step of the project development process.

Experience: Anay is a third-year Cognitive Science (HCI) and International Business Major. Coming from both a Science and Business background, he has demonstrated skills of working effectively in teams to maximize group productivity, both on the side of 'creating' and developing, as well as managing and presenting final products.



Name: Sharmaine Manalo

Contact Info: hello@sharmaine.me

Role: Full-stack Developer

Responsibilities: Sharmaine is responsible for helping develop user interfaces and assisting in back-end tasks.

Experience: Sharmaine is a fourth year Cognitive Science HCI student. She has both the insight of a developer and a designer after having worked on multiple in-class and personal projects that pertain to both design and software development.



Name: Oscar Lai

Contact Info: oslai@ucsd.edu

Role: Front-End Developer

Responsibilities: Oscar is responsible in helping the front end team design and develop user interfaces and interactions.

Experience: Oscar is a 4th year Cognitive Science HCI undergrad. He has had experience as a UX/UI Designer and is capable of creating awesome high and low fidelity mock-ups and wireframing. He has the front end skills needed for this project such as HTML5, CSS, and JavaScript.



Name: San Kang

Contact Info: s5kang@ucsd.edu

Role: Full-stack Developer

Responsibilities: San is responsible for helping the frontend and backend to develop a working website

Experience: San is a 3rd year Computer Engineering major. He has a good knowledge of web languages: JavaScript, HTML, CSS. He is also capable of designing and publishing a website.



Name: Kevin Liu

Contact Info: mail@nivekuil.com

Role: Client Liaison & Engineer

Responsibilities: Kevin is responsible for communicating with the client to keep them synced with the team's efforts, and whatever engineering role necessary.

Experience: Kevin is a 4th year Computer Science major, with ~6 years or so up and down software and systems stacks.

1.4 Stakeholder Analysis

Stakeholder Analysis

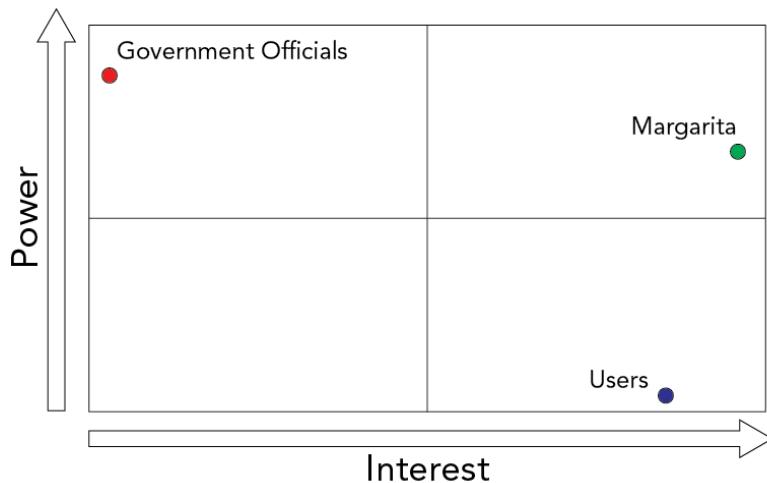


Figure 1.4.1 - *Stakeholder Analysis*

Our project has three primary stakeholders, Margarita Diaz, Tijuana Beachgoers, and the Mexican Government. Each of these stakeholders have varying interests and power. We must take this into account throughout the entirety of our design challenge, as we need to utilize power ties when we can, but that is only attainable when it is in our client's interests.

Our primary stakeholder is Margarita Diaz, one of the co-founders of our partner organization, PFEA. As the head of PFEA, Margarita and the organization can potentially use this application to help raise awareness and combat water pollution in Tijuana. That being said, it is imperative that our team communicates with her throughout the design process to ensure our product meets her needs. Given her role in the organization, Margarita has the power to run our web application, but not much power after that. There are greater authorities who may deter her from her goals, but she will always fight for the rights PFEA believes in.

Our other primary stakeholders are our end-users, Tijuana Beachgoers. The residents and tourists of Tijuana are directly affected by the water pollution in the area, and as such, they will be the primary consumers of our application with the most investment in our product. Due to cultural norms, they do not have any particular investment in our project, they just know that they should be weary when entering any body of water in Tijuana. It is imperative that we provide them with a functional, interactive, easy to use application that keeps them safe from contaminated waters.

Once our application is up-and-running, their interest will increase dramatically. Our app may empower them to stand up and make a change to aid the poor water quality.

Our last key stakeholders are the Mexican Government and Government Officials. PFEA has approached the Mexican Government before, asking them to publish their findings to protect their citizens, but they have shown no interest in doing so for fear of public backlash. They are seen as an opponent because they propose hindrances to the effectiveness of our project. It is unclear whether the government wants to hide this information, or just want to avoid being the bearer of bad news, but if we do publish a web application in spite of this, they could potentially attempt to shut us down or urge PFEA to take it down. With that potential in mind, the Mexican Government is considered an opponent in our stakeholder analysis.

1.5 User Research Plan

Research methods

- Interview stakeholders
- Observation of water quality testing
- User testing of web application

Margarita

- Tell us about your role at PFEA and the water map project.
- What is the general state of water in Tijuana?
- What is currently being done to help the situation?
- How do you know if water is good or bad? How do we define “good” vs. “bad” quality?
 - How is water quality monitored?
 - How do you receive updated information data?
- How would you like to upload the information on the water quality?
- What do you want us to accomplish?
 - How will people access the map? App? Website? Brochure? How often would users receive this if printed?
 - Does the map need to be dynamic? Will you need to be able to make changes in the future?
- What's your end goal?
 - Show/demonstrate/tell us how you envision using the ideal/end product.
- What did the past team do?
 - What didn't work/did work? How would you like us to improve?

Tijuana Locals

- 3,000 users, including surfers, lifeguards, youth, and american community
- Tell us about your experience on the coast in Tijuana.
- Tell us about a time when you had a bad experience with the water in Tijuana.

Brandon Reynante

- What did the previous group do or not do that our group could improve on?
- What do you think is the main thing our group could work on?
 - What has made previous teams on the PFEA project successful/unsuccessful?

2. Problem Definition

2.1 Problem Statement

People both living in and visiting Tijuana need an effective way to access information about the water quality of local beaches because the government refuses to publish this information, posing serious health risks to beachgoers.

2.2 Background & Context

Tijuana has experienced vast changes in the population due to the industrialization of the region. This in turn, has created new problems in waste management and pollution that has affected the water quality in Tijuana. The sewage is not disposed of properly. Trash is not collected from all homes, only main streets. The massive influx of people has led to building upon mountainsides, loosening debris which flows into the rivers/oceans when it rains. The people of Tijuana have lived in these hazardous conditions for so long, they see it more as a part of life rather than an issue. Because of this, health cases related to respiration, nausea, rashes and even more dangerous skin diseases have increased in the area.

The Mexican government disregards any claims that the water quality is unsafe. They even go so far as to prevent any water test results to be officially released by the government due to fear of public distress and backlash. Since the government refuses to take action, Proyecto Fronterizo de Educación Ambiental (PFEA) has taken the initiative for the last 25 years in finding ways to protect the people of Tijuana by raising awareness and working as a community to aid water quality in Tijuana. PFEA's mission statement is "We work to protect the ocean, streams and coasts of our watershed." Some of the work they do includes collecting water samples, conducting lab tests, and providing educational seminars and materials for the local community.

Coinciding with their mission statement, PFEA is passionate about the right to know and the right to health. Our project is the unity between those two ideals, creating a platform for the public to access the necessary data in order to protect themselves. We are aiming to create a web application that provides accurate information about the water quality of different beaches in Tijuana, so that beachgoers and locals have access to the right kind of relevant information before deciding to go to the beach. According to official statistics, more than [84% of dwellings](#) in Tijuana have a mobile phone, and therefore we target to create an application for this majority so they have a convenient way to access information on their handset.

Water quality is dynamic and changes on a weekly basis, thus making it more crucial for this information to be readily available to the public. As the director of PFEA, Margarita Diaz says, "Information is power. You have to give to everybody. If you keep it, it's not right."

Because Margarita is an official WaterKeeper, she has access to a platform called Swim Guide, which is currently the only way to access information on the water quality in Tijuana. She has offered us a connection with the webmaster of this platform so we can have a good sense on how to make our very own.

There have been 4 previous ENG100D teams that have tried to tackle this problem. Each one started from scratch and were unable to complete the project in the given 10 weeks. We will be attempting to build off of the previous groups work, and finish the job. From what we have seen in their presentation, they completed a lot on the front-end side, but since we don't have access to the code, we do not know about the backend.

2.3 User Profiles(s)



Margarita Diaz (activist, changemaker)

Margarita is the director of PFEA, an environmental NGO based in Tijuana, Mexico. She is one of four hundred "waterkeepers", members of the Waterkeeper Alliance, an international environmental group focused on protecting Earth's most precious resource. She went to school for architecture in Mexico City, where she was told that she "could do anything".

Incredulous, she pursued her studies diligently, but after she matriculated, she realized that was not she only having trouble finding fulfilling work, but also had difficulty finding the wildlife

of her father's stories in her hometown of Acapulco. This inspired her to pursue more environmental work, but she did not join PFEA until she moved to Tijuana, where the possibility of working for environmental causes was made aware to her by a neighbor. Fourteen years later, Margarita is now the director of the once-fledgling organization, but her work is far from finished. Her missions today include the revitalization of Tijuana as a beach town, organizing cleanups of the local coastline, and growing PFEA. She understands that "information is power", and is passionate about democratizing information and making it as open and widely available as possible, in order to give the power to ordinary people.

Although she did not grow up there, Margarita is committed to giving the people of Tijuana accessible information about the quality of the local water. She and her team sample surrounding areas weekly and disseminate the findings to the public.

Activists like Margarita tend to be among the most well educated stakeholders, or at least the most motivated. They can be considered "power users", for whom usability is less important than effective long-term solutions.



Figure 2.3.1 - Margarita's Empathy Map



Luis Barcenas (Tijuana native)

Luis Barcenas recently graduated from UCSD and works in San Diego, but he still calls Tijuana home. Growing up in a coastal city, he naturally spent lazy days hanging out at the beach. However, perhaps unsurprisingly for locals, he never stepped foot into the water. Why? Because he's "always been told that the water is gross and dirty". Like many Tijuana locals, he knew not to step into the water, but never knew the true reason why. Despite PFEA's best efforts, the Mexican government refuses to officially acknowledge the water quality issues in Tijuana, preferring to keep the population in the dark in the interest of public order. People like Luis are whom our team aim to help by bridging PFEA's detailed and exhaustive water sampling efforts with the convenience of an easily accessible web interface. As a group, Tijuana natives are generally less tech-savvy so usability is more important than feature set. The Tijuana metro areas boasts a population of 1.3 million.



Figure 2.3.2 - Luis's Empathy Map

2.4 Needs & Insights

Key Needs	Key Insights
1. Upload and adapt to changing water quality data	1. Intuitive and easy website/app design for users
2. Ability to generate necessary information	2. Designed to serve the water quality “pain” of the local people
3. Ability to see water quality history of various locations	3. Ability to add features or improve design in the future
4. Demonstrate poor quality of water in TJ	4. Raising people’s awareness on water quality
5. Access to macro/micro levels of information	5. Organization of information like, “Beaches near me” and “Beach closest to me”

2.5 Design Requirements

Category	Requirement
Usability	The app should be easy to use (less clicks to desired information); such that anyone without a technical background is able to freely navigate through the app.
Functionality	The app should use a color-key to provide information of different pollution level of nearby beaches.
Feasibility	The app should be easy to navigate from the back-end, so that the work of the PFEA representative uploading water quality data is as easy and automated as possible.
Aesthetic	The app should be visually appealing and there should be a focus on integrating maps to provide appropriate and intuitive location-visualization for the user.
Cost Effectiveness	The app must be free and easily accessible to everyone who wants to use it; therefore the design must be cheap to implement.
Scalable	The app should be set up in such a way that it will be easy for future teams to add features/design; as well as the back-end should be set up in such a way that it can be scalable to other NGOs as well.

3. Concepts

3.1 Analogous Solutions Analysis

[SD Beach Info](#) (Figure 3.1.1) is a site that helps us get to know the area better. It gives very detailed information on beaches here in SD. There are a lot of resources and reports you can refer to to learn more about the beaches.

Pros

Aesthetically pleasing
Good info on about and resources related
PFEA uploads water quality and relative beach information

Cons

Map page doesn't show a map?
Layout of content is all over the page and hard to find for users
Hotline number is displayed on the bottom, this is an important part and should be more visible
Nothing appears when you choose a certain beach
San Diego County Gov on top takes you straight out of the site, very misleading

[Aqicn.org](#) (Figure 3.1.2) gives you up to date air quality updates, internationally. We examined the extremely bad quality of Beijing in this example. It is similar to our project because its purpose is to inform the public for their own safety.

Pros

Easy to detect where the air quality is bad
Can zoom out to see other cities' air quality
People can change cities by typing

Cons

The indicator does not specify the radius
There are no numbers or values if there is no indicators around
PFEA only monitors water levels in Tijuana, so seeing other cities' air quality would be unnecessary.

[Waze](#) (Figure 3.1.3) is a community-edited map, makes others aware of traffic flow. Similar to Google Maps, but provides much more information relevant to traveling, such as gas prices and highway patrol spots. This is similar to our water map because it is always changing and represents the present state of the real world. We should look at Waze as a prime example of user-friendly, human-centered design.

Pros

Reflects the real world geography, making it

Cons

It's selling point is heavily reliant on user

intuitive	collaboration
Utilizes icons and colors well to quickly inform the user	PFEA uploads content weekly, so a real-time interface is unrealistic
Search bar and pinpointing tool allows users to easily evaluate specific areas or surrounding areas	Some icons are misleading or confusing, making it difficult to interpret the situation
Uses speech and hearing so it does not impair driving	Cannot make edits to map without GPS connection
Extremely scalable	Unsure if you can make edits to map without making an account

On [Airnow](#) (Figure 3.1.4), every day the [Air Quality Index \(AQI\)](#) tells you how clean or polluted your outdoor air is, along with associated health effects that may be of concern. The AQI translates air quality data into numbers and colors that help people understand when to take action to protect their health. This is very similar to how our water quality map would function and in fact quite similar to the previous team's code.

Pros

- Has a “My Current Location” feature
- Tells you current and future air quality forecasts
- Is very dynamic- has an hourly map that shows movement in air quality.

Cons

- Can't zoom in or manipulate the map
- Not very aesthetic
- Violates “match between the system and real world” heuristic by having numbers labeled as AQI because a regular person may not know what those values mean.
- Content that PFEA uploads does not include health effects due to water quality

[Swim Guide](#) (Figure 3.1.5) is currently the premier site to find out about beach weather and water quality. It tells you when a beach is safe, and when it isn’t. It is the exact same concept that we are trying to accomplish, it is actually what our project is based off of, but there are minor fixes that we plan to implement.

Pros

- It has indicator colors (red=bad/green=good)
- Website and app - makes it more convenient
- It has short descriptions of the beaches if you click on them, TJ has spanish translation
- Clean interface and easy to use, integrated with Google maps
- Search toggle makes it easy for users to search rather than just find off map
- PFEA uploads water quality and relative beach information

Cons

- There is no gradient. So no in-between indicators
- There are only 4 total locations in Tijuana (all are red)
- Only shows beaches, not sure if lakes are “swim-able”

3.2 Concepts

Emojuana

A friendly and simple app that informs users about the water quality of the destination they want to go to.

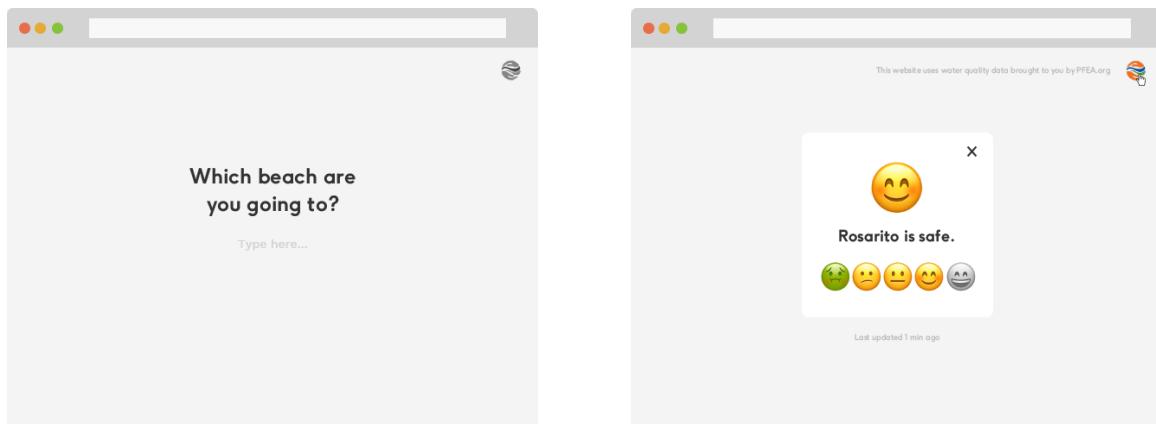


Figure 3.2.1 - *Emojuana Concept*

Core Need

Tijuana locals need to be informed about the water quality at local beaches.

Strengths

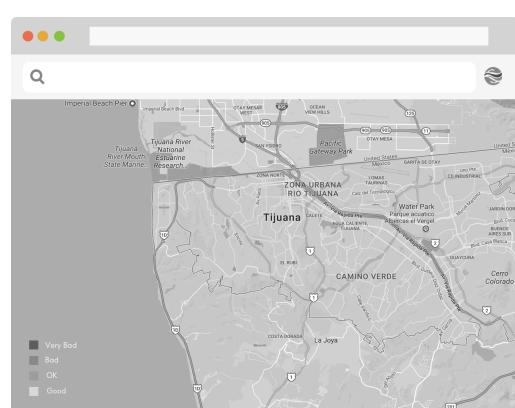
Fast and efficient, has a call to action right away leading to the main problem we want to address

Weaknesses

Doesn't give user much of an option to do anything else

Tiagua

An interactive aesthetically pleasing map to distinguish water quality in different areas of Tijuana.



Core Need

Water quality needs to be displayed on a large scale.

Strengths

Gives users a better idea of which area has cleaner water.

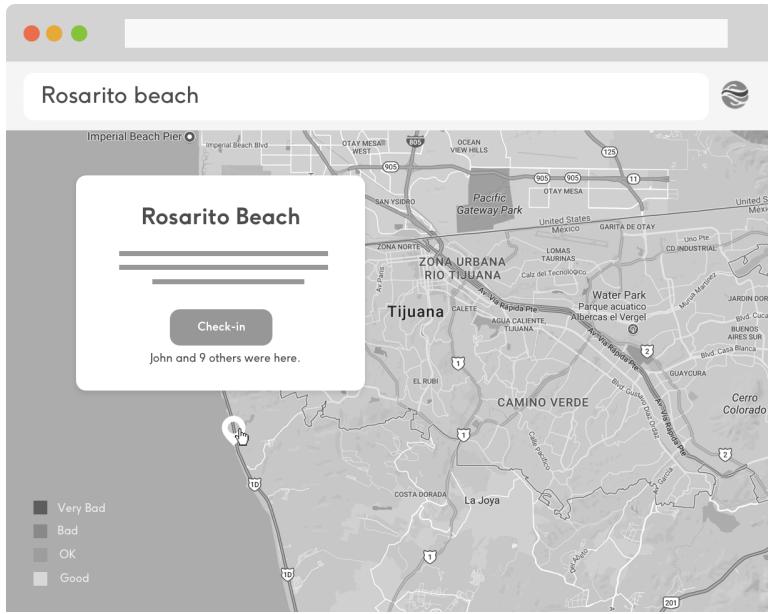
Weaknesses

Doesn't represent a distinct spot really well. If one area on the map is very bad does that mean that every single beach in that area is bad?

Figure 3.2.2 - *Tiagua Concept*

Check-in!

A credible interactive map that distinguishes water quality in different areas of Tijuana.



Core Need

Gives the app more ethos, creating an atmosphere of trust.

Strengths

Interactive and user friendly, gives credibility to the place.

Weaknesses

Check-ins can vary and people may not do it all the time at certain spots and therefore can alter the number of people who checked in at each spot and that doesn't tell us much about it. Possible improvement here is to add a rating option to the check in at each station to back up the claim of the water quality there.

Figure 3.2.3 - *Check-in! Concept*

4. Concept Evaluation

4.1 Criteria

Criteria	Definition	Metric
Usability	A measure of how easy it is for users to check the water quality in one specific beach	Seconds to complete task on using the app.
Feasibility	A measure of how realistic it is to technically implement the design.	No. of technologies or person-hours required to implement the solution
Desirability	A measure of how likely our target audience is to use the app.	Percentage of testers reporting that they would use the app.
Sustainability	A measure of how easy it is for our partner organization to upload data to the application	No. of seconds it takes client to upload information onto application

4.2 Evaluation

Research

According to our research, there are 51.4 million smartphone users in Mexico and 129 million people in the population as of 2017. Assuming children and the elderly are excluded from these numbers, a fair amount of people will have the capability to use our app. Whoever is unable to use our app on mobile can use the same application on PC.

Methodology

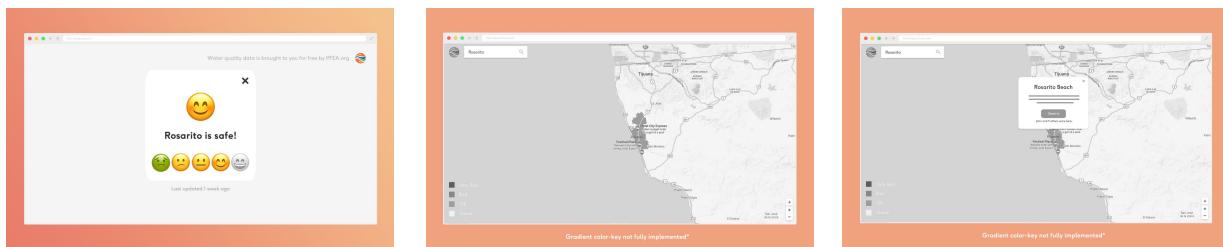


Figure 4.2.1 - Emojiuana, Tiagua, and Check-in Concepts

To evaluate each of our design concepts, we first created interactive versions of our concepts and then gathered 20 UCSD students (potential Tijuana tourists) for user testing. We conducted the tests online through the use of Invision and screen recordings. Each user was given a specific task and then was asked to complete it while “thinking out loud,” without any guidance from our team. We utilized silence as a method of having the users ask us questions, many of which were extremely helpful in gaining insight on how to improve each concept. For further analysis, we consolidated our results and discussed the questions and insights that arose from each of our individual user testing sessions as a team. Since our users were all UCSD students, our input is mostly derived from the same age group and background. However, we did make sure to also have our primary stakeholder and director of PFEA, Margarita, go through this same user testing as well, to ensure we are making the concepts to our partner organization’s standards.

Results

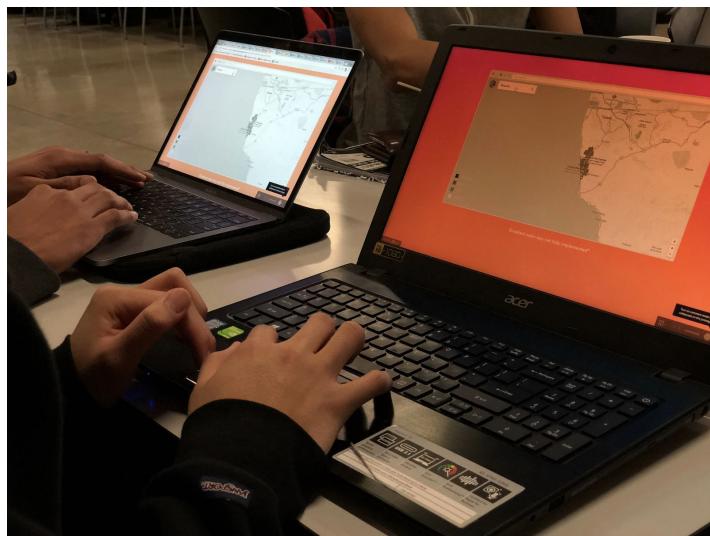


Figure 4.2.2 - Two users testing our concepts

[Emojuana](#)

Usability & Desirability

Most users found that the use of emojis were fun to use and met their needs easily. Users reported that it was an efficient and to the point prototype. Some users also suggested adding a map for further information. Out of all the concepts, Emojuana seems to be the most user-friendly interface.

Feasibility

The resources required to create and deliver this solution exists within the extended framework of our team and PFEA's existing social reach to users. Emojuana has all aspects that would enable it to function reliably in Tijuana. The site would be live and as long as users have access to a mobile device or computer with internet it should work.

Ecological Sustainability

The solution minimizes resource and waste by showing their data online. This solution is “circular” because the data that is uploaded every week by PFEA themselves, it can be sustained

even after this quarter has ended. Also, the solution would raise awareness about environmental issues that can trigger people to change about it.

Economic Sustainability

The cost to implement, use, and maintain the solution is affordable, as long as there is internet access then the app/website should run. As of right now we will be hosting the site so it will be free. In terms of maintaining the solution this isn't too hard because we will give our client access to it and they can update the app occasionally. This website/app will be perfectly free so our users would not have to worry about anything financially related. This also helps improve users self-sufficiency because it informs them if the beach is clean or not so the user knows which ones to go to and not.

SocioCultural Sustainability

Our solutions grew out of the issues people face in Tijuana in regards to clean beach water. People in Tijuana avoid the beach or swimming in the water because the water is known to be unclean. Knowing when the water is clean will be helpful for people who would like to go to the beach. One of the reasons it was so universally loved was that it was user-friendly. It is easy to understand what the emojis mean and is even friendly to potentially colorblind users as it relies more heavily of emotive expressions than color. Moreover, this solution, like the other solution, is easy to use since it uses a map system similar to what is already known, like Google Maps. And just like other solutions, this solution is accessible on mobile or pc and allows the user to search whatever beach in Tijuana they would like, allowing the user full control over what beaches they look into.

[Tiagua](#)

Usability & Desirability

This concept was found to be a simple solution, answers the required question but nothing more. It was hard to test because gradient dependent, but tested through grayscale. Our concept is easy to use, yes, because it only seems to serve one function (providing a color from the gradient). Could be made later to be more intuitive, since some users were confused on where to click.

Feasibility

Within our team exists the necessary talent and expertise to create and deliver this solution. With help from PFEA, we will then have the necessary social outreach. Because the prototype used for testing was grayscale, there was some difficulty in assessing user feedback, but the color gradient planned promises to be very reliable as it provides the location-visualization that PFEA wanted.

Ecological Sustainability

The solution minimizes resource and waste by showing their data online. This solution is "circular" because PFEA will have control over uploading the data every week after our group has ended. Also, the solution would raise awareness about environmental issues that can trigger people to change about it.

Economic Sustainability

The cost to implement, use, and maintain the solution is affordable, as long as there is internet access then the app/website should run. As of right now we will be hosting the site so it

will be free. In terms of maintaining the solution this isn't too hard because we will give our client access to it and they can update the app occasionally. This website/app will be perfectly free so our users would not have to worry about anything financially related. This also helps improve users self-sufficiency because it informs them if the beach is clean or not so the user knows which ones to go to and not.

SocioCultural Sustainability

Our solutions grew out of the issues people face in Tijuana in regards to clean beach water. People in Tijuana avoid the beach or swimming in the water because the water is known to be unclean. Being able to see when the water is clean will be helpful for people who would like to be able to go to the beach. This solution might not be as helpful to colorblind people because they cannot see colors on the map. This solution, like the other solution, is easy to use since it uses a map system similar to what is already known, like Google Maps. And just like other solutions, this solution is accessible on mobile or pc and allows the user to search whatever beach in Tijuana they would like, allowing the user full control over what beaches they look into.

[Check-in!](#)

Usability & Desirability

Our user did seem to find the solution desirable, because seems to be an improved version of Tiagua, but more interactive with the check-in feature. An issue that was prevalent during user testing was that there still is confusion on what is "click-able". Users reported being unsure that they could actually "check-in", until they eventually clicked the right place

Feasibility

The resources to create and deliver this solution exist within our team. With PFEA's social outreach, we are confident that there will be enough people on this app to justify user-inputted data. In terms of the solution being reliable, there are some concerns over false information being reported by users which would ruin the reputation of the application, for which we are currently researching and discussing a bypassing solution.

Ecological Sustainability

The solution does minimize resource and waste by showing their data online. In terms of the solution being 'circular', it is, because the data that is uploaded every week by PFEA themselves, the solution can be sustained even after this quarter has ended. Also, the solution would raise awareness about water quality issues that can trigger people to change.

Economic Sustainability

The cost to implement, use, and maintain the solution is affordable, as long as there is internet access then the app/website should run. As of right now we will be hosting the site so it will be free. In terms of maintaining the solution this isn't too hard because we will give our client access to it and they can update the app occasionally. This website/app will be perfectly free so our users would not have to worry about anything financially related. This also helps improve users self-sufficiency because it informs them if the beach is clean or not sand has a check in system that shows who goes there and user would feel safe if the feedback is the same as the quality shown for the beach.

SocioCultural Sustainability

Our solutions grew out of the issues people face in Tijuana in regards to clean beach water. People in Tijuana avoid the beach or swimming in the water because the water is known to be unclean. Being able to see when the water is clean will be helpful for people who would like to be able to go to the beach. This solution might not be as helpful to colorblind people because they cannot see colors on the map. Moreover, this solution, like the other solution, is easy to use since it uses a map system similar to what is already known, like Google Maps. And just like other solutions, this solution is accessible on mobile or pc and allows the user to search whatever beach in Tijuana they would like, allowing the user full control over what beaches they look into.

4.3 Selection

In conclusion, each of our concepts had weaknesses pointed out by our user testers, weaknesses that could be remedied by taking features from both our Emojuana and Check-in concepts and combining them. Generally, our user testers liked Emojuana the most and gave us suggestions such as including more information about each beach and adding a map or some sort of location feature. From this we decided on the weights based on how important we think that attribute is. Because of this and the results of our Pugh chart, we decided that a fusion between two of our concepts; Emojuana and Check-in, would be our best choice for our final design.

Design Criteria	Weight	Emojuana	Tiagua	Check-In
Usability	2	++	D A	+
Feasibility	1	0	T U	++
Desirability	3	+	M	0
	+	7	0	4
	0	1	6	0
	-	0	0	0
		7	0	4

Table 4.3.1 - *Pugh chart of our Concept Evaluation results*

5. Design

5.1 Overview

Our final design is a free web application that serves as a water quality map of Tijuana. This app will be accessible on any mobile phone or computer with internet access, with the intent of raising awareness regarding water safety. The map utilizes the Google Maps API and is overlaid with dynamic, colored location tags. These tags are color-coded based on the data our partner organization, PFEA, uploads. Through our application, PFEA's existing spreadsheets filled with water quality data will be converted into a visual representation that is easy for users to understand and use. When users refer to the app, they will be greeted with an intuitive, user-friendly map that clearly distinguishes different bodies of water in Tijuana and their respective water qualities. The user can hover or click on any of the several bodies of water, and all the data specific to that body of water will be displayed.

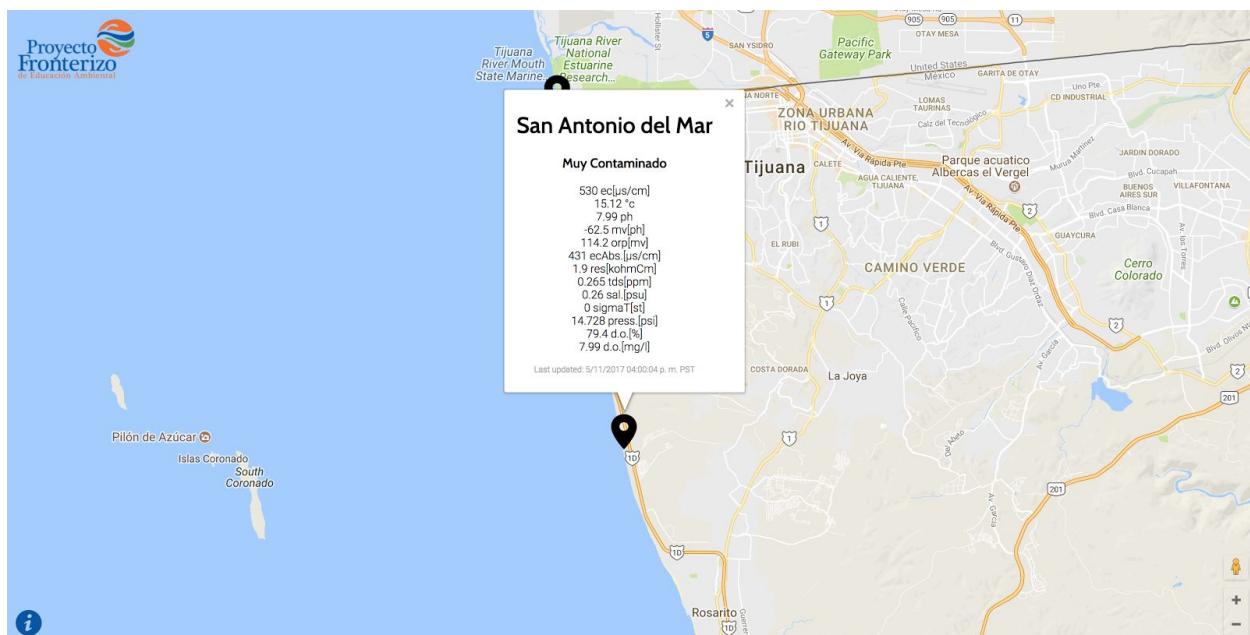


Figure 5.1.1 - *Final Design*

5.2 Detailed Design & Implementation

Upon arriving on our [website](#), users will see a map with 5 colored pins, each representing a body of water in Tijuana. Each color corresponds to the level of bacteria that exists in each body of water.

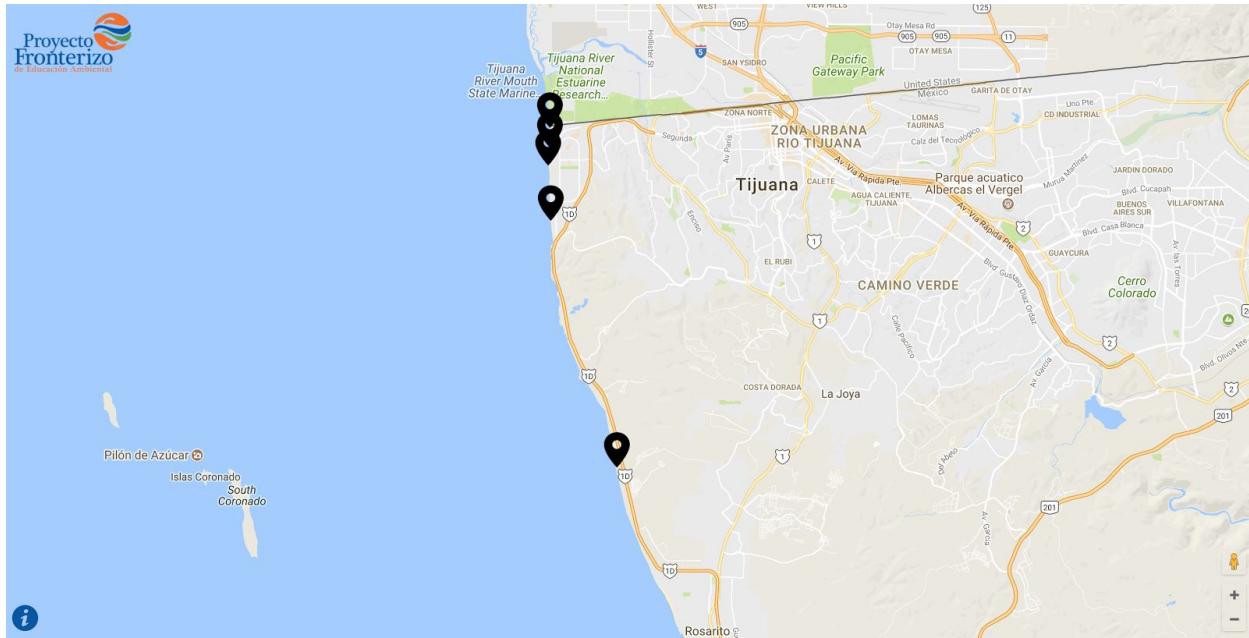


Figure 5.2.1 - *Homepage of Final Design*

Users can click on the info button to bring up the map's legend which explains what each pin's color means in greater detail.

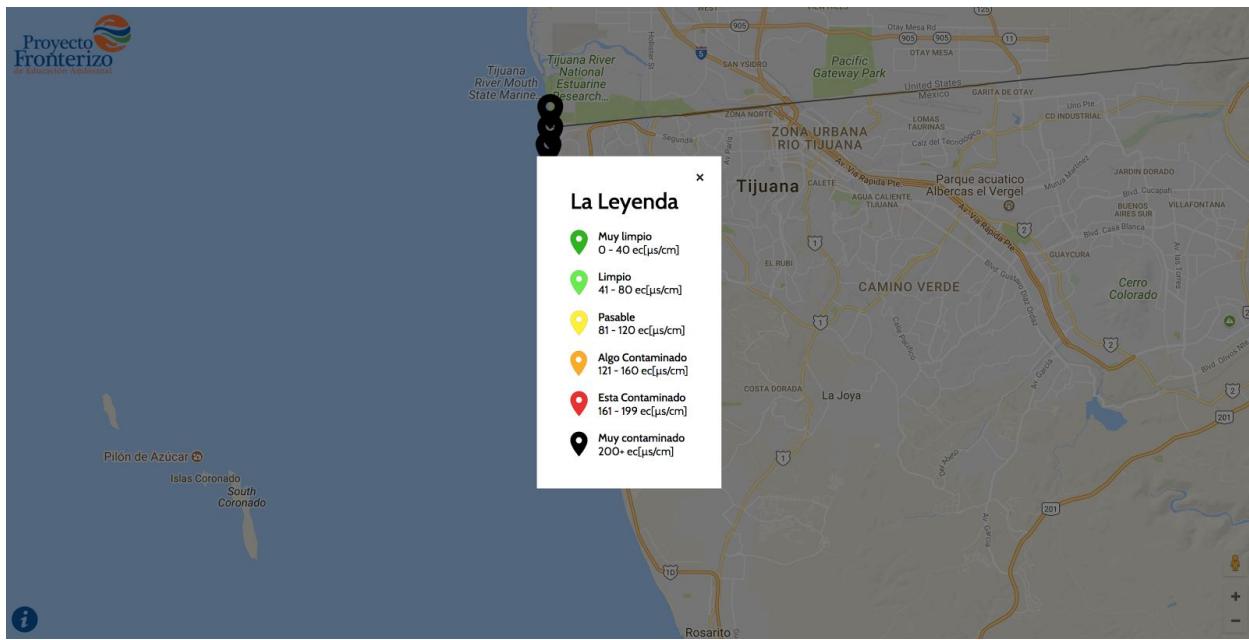


Figure 5.2.2 - *Legend pop-up after user clicks on Info Button*

Users can also hover or click/tap (on mobile) on each colored pin for more information on that specific body of water.

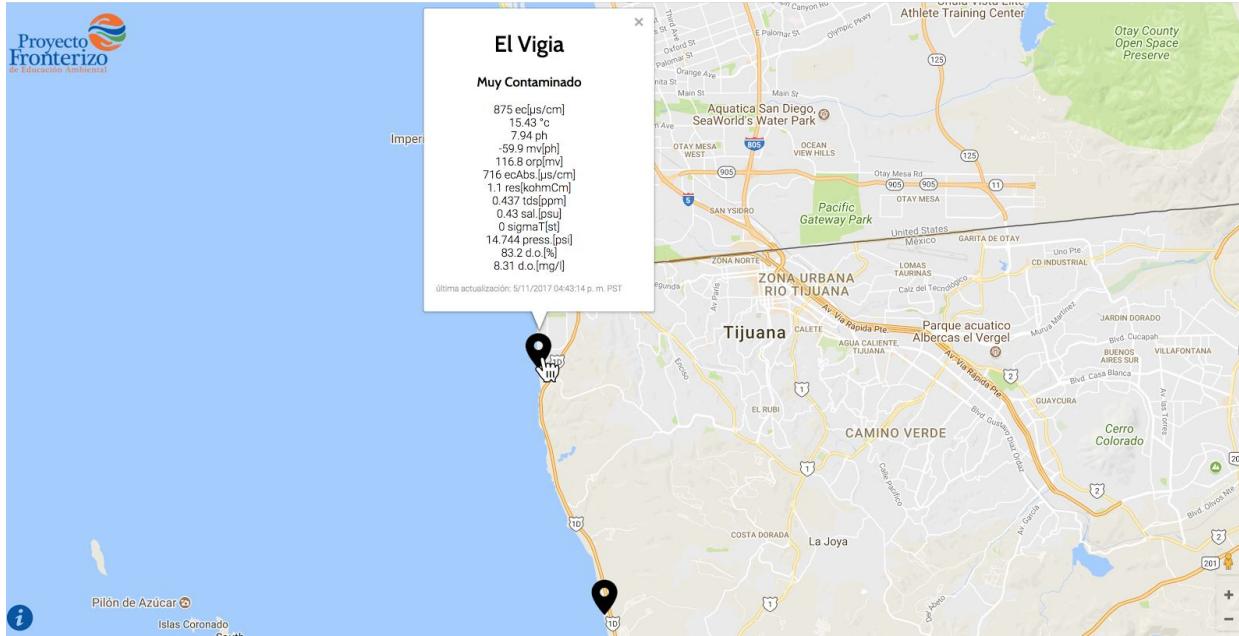


Figure 5.2.3 - User hovering on a colored pin

The process of our implementation included a couple iterations of prototyping as well as user testing, which led to finalizing our design. We were fortunate enough to have access to a previous team's GitHub and decided to base our application's framework on their own. Wanting to stick to our own design, we ended up having to redo the whole user interface in addition to having to delete incompatible code and writing new code to account for our own custom features. In regards to the new user interface, we made use of the Google Maps API in order to have a dynamic, zoomable, aesthetically pleasing map that is capable of updating itself based on an existing Google spreadsheet that PFEA inputs their weekly data onto. Also unlike the previous team's application, there is no actual back-end interface because our application fetches data every 0 to 30 minutes and it is tied to the Google spreadsheet that PFEA uses to post their sampling data. Because we chose to utilize Google Maps and Google Sheets, the process for Margarita and PFEA to update the application with their data is streamlined. Every week they update their spreadsheet with new sampling site data, the new data will immediately be live because of the way our application is setup to parse their spreadsheet every time a user loads our website.

The application is currently being hosted on Heroku as Margarita has told us their current infrastructure is being hosted by Hostgator, which is incapable of running the server which our application depends on. Heroku is a free solution and remedies that. We have written an instruction manual and provided passwords to relevant accounts for PFEA and Margarita [here](#).

Our implementation is still lacking in one important aspect that future teams could possibly address within a few weeks of coding or so. Our application fails in having offline access, or a way for users to be informed about water quality without having internet. This

could be accomplished by porting our web application into a mobile app that users can download.

5.3 Assessment

Our final design is strong in its aesthetic. How it is spaced and organized in an easy-to-see way for our users is also a strong suit. We have intuitively color-coded pins on each location that allow users to know the quality of a location right away through their connotations, such as “green” with “good” and “red” with “bad”. Another strong point of our design is the fact that it utilizes Google Maps and Google Sheets, this makes it easy for PFEA to update their sampling site data without needing any frontend or backend assistance.

However, the placement of the map’s legend could be seen as a weakness. A user has an additional click before they can see the legend. On mobile devices, having the button for the legend is more user-friendly because without it, the legend would be displayed over part of the map, which could potentially cover a location. But on desktops, this is not optimal as there is enough screen real estate to display the legend without clicking a button.

What our solution is particularly strong in is its ability to harness the large amounts of information of Tijuana’s water quality gathered each week as well as its ability to transform it into an easy to understand visualization. It is easy to maintain as it is dynamic and can change accordingly to the data sheets uploaded each week. Moreover, it can be reproduced by others by simply copying over our code or forking our [repository](#) which is public. In the future, it can be customized and even made to be more detailed if that is what is wanted by users or PFEA.

Our solution is designed to meet the need of our users. The need of the user is easy access to information regarding the water quality of various beaches around Tijuana. To meet this need, our solution will be a web application and also an extension of PFEA’s current site. We hope that this will tackle the issue of limits on information, by sharing PFEA’s data with the masses. Additionally we wanted to take our solution a step further by ensuring that our interface is user friendly towards all ages by adding emoticons to correlate to water quality levels. By creating an accessible and informative app, our group hopes to empower our users through our client’s vision of ‘*Knowledge is Power*’.

Since the Mexican government is refusing to be open about the water quality, this design gives the perfect solution to tackle the structural issues. When the government is officially covering up important information, we should use an alternative form of disseminating information. The Internet is the perfect resolution in this case. We hope that through this website the government can

change the attitude towards the water quality in Tijuana. As more people use our website, it gives more power to tackle the structural issues of this problem.

To measure the key effectiveness of our solution, we will have to keep track of the number of users that are using the platform to actively check water quality of beaches around Tijuana. For a more detailed measure, including statistical analysis tools that can provide insight towards which users are repeats, and which users are unique, will enable us to further measure the **social impact** of our solution. The unique users will represent the number of people benefiting from our application, and the recurring users will provide information for which users are actively viewing our platform as valuable and useful.

Our application shares PFEA's vision of '*Knowledge is Power*', and will be an important source of real-time information for water quality of Tijuana's beaches. The increased awareness provided by our application about the degraded water quality has potential to educate and effect a change for the better, which can have a major positive **ecological impact**, especially in the long term. However, it is important to note that there can be factors other than our platform that could help effect this change, for example, government reforms.

Since our application is created for a non-profit organization, there is no direct economic benefit that PFEA can get from our platform in the short term, since it is not designed to be monetized; rather, it has been created with a social cause in mind. However, our platform is designed to be a tool for information, and this information will potentially improve the quality of Tijuana's beaches which will facilitate beachside economic activities. Therefore, in the long term, there are potential **economic benefits** to locals in Tijuana once commercial activity beachside becomes a more attractive feature.

Our app may cause governmental backlash. Due to the Mexican government's reluctance to publish water quality information, creating a tool to make this information easily accessible to the public, may cause the government to take action against PFEA. Moreover, our app may cause the public themselves to be upset at the water quality and even the government. The public may even avoid going to the beach entirely after seeing the consistently bad water quality. As people go to the beach rarely as it is, the app may further the public to just naturally avoid the water entirely. Another potential technological risk is if PFEA decides to change the way they format and input their data into our site, it may display information incorrectly and be dangerous to users. However, this is not much cause for concern, as after talking with our partner organization, they have insisted that there will be no change to the format and input of the data.

6. Conclusions and Recommendations

This project has been the most engaging design challenge many of us have ever faced. From project management to web application development, this gave us the opportunity to experience the entire human-centered design process. As a combination of human-computer interaction and computer science majors, this experience was different compared to our usual projects in the aspect that we were truly designing for a community. This project proved to be more rewarding knowing the fact that we are applying our educational backgrounds and experiences to something that could have a lasting impact on an overlooked community issue.

In the future, we want our water map to be more accessible and inclusive by using more than just color as signifiers of high and low levels of bacteria. As of now, our application is based on the assumption that colors carry a specific connotation with them, for example, green is good and red is bad. The issue with this is that it does not account for cultural or personal differences of others. One of our prototypes, Emojiuana, uses emojis as a measure of water safety. This allows those who are colorblind to also benefit from our web application.

Additionally, we would like our application to encourage learning. As of now, the purpose of the application is solely to inform and display different bacteria levels. Hovering over an location pin displays a lot of data that most people will not understand. In the future, it would be helpful to implement an explanation page that describes what each measurement means as far as water safety goes. This will give users a better insight as to what they are risking from getting into the water.

One of the issues we ran into during our project was the accessibility of our application in the homes of our users. From research on quality of life in Tijuana, we found that only 34% of all Tijuana homes have internet access. This directly limits the effectiveness of our app. Some ideas we thought of to combat this were weekly brochures or maps with statistics and visuals depicting the water quality at the beginning of each week. We have deferred from doing so thus far because of costs and PFEA's initial need of the online water quality map.

We are extremely proud of our end product. It has exceeded our expectations and will hopefully prove to have an impact on water-related illnesses in Tijuana. Although we have delivered a fully-functional product, there are many ideas and improvements that need to be implemented in the future. We hope that the next group will help us improve upon our app and that PFEA will maintain it.

References

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<https://en.mexico.pueblosamerica.com/l/munest/baja-california/tijuana>

<https://www.epa.gov/beaches/learn-human-health-beach>

Appendix

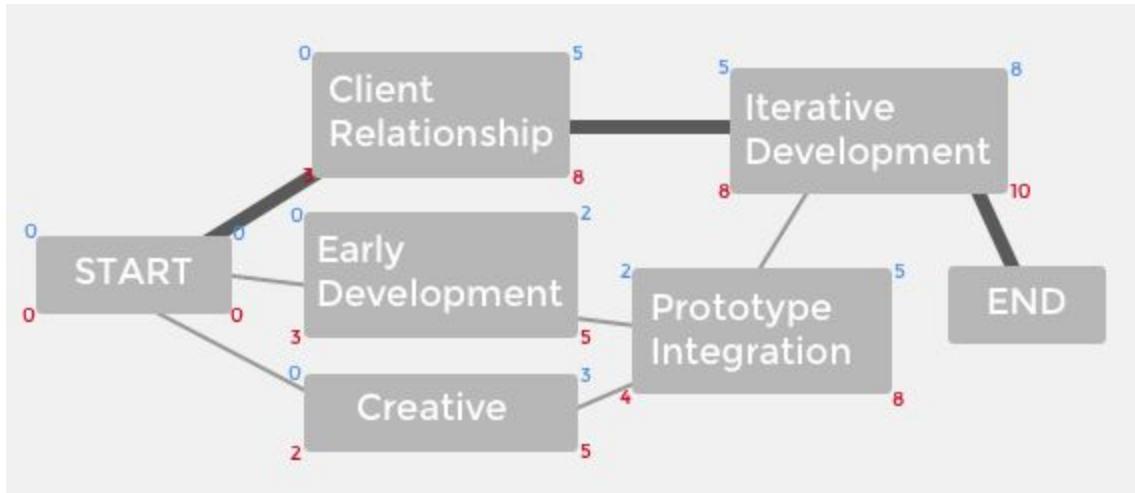


Figure 1.2.2 - *Critical Path*

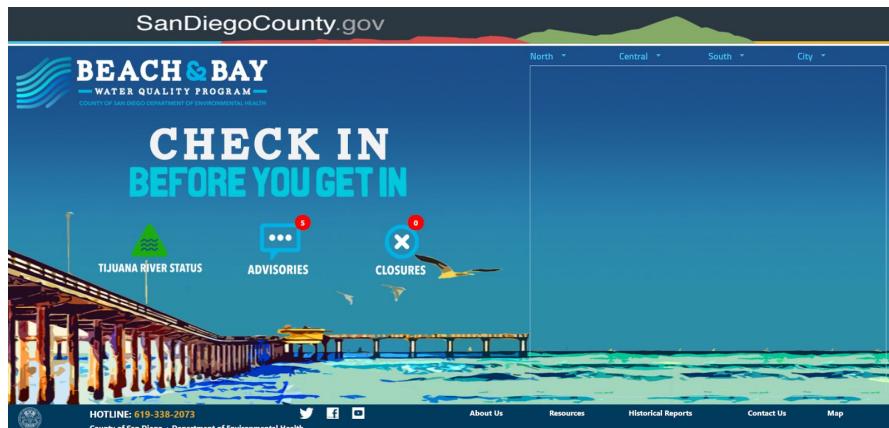


Figure 3.1.1 - *SD Beach Info*



Figure 3.1.2 - *Aqicn.org*

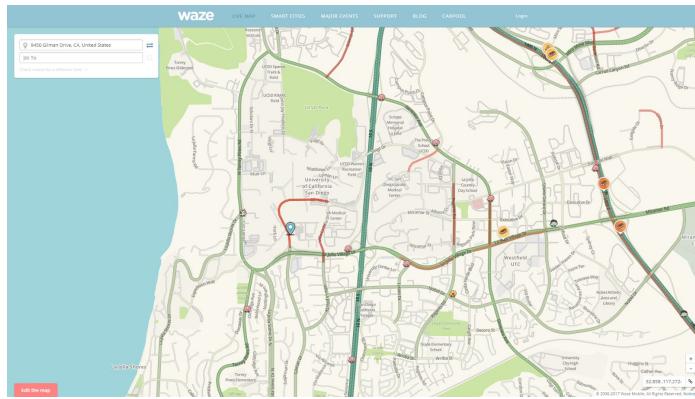


Figure 3.1.3 - *Waze*

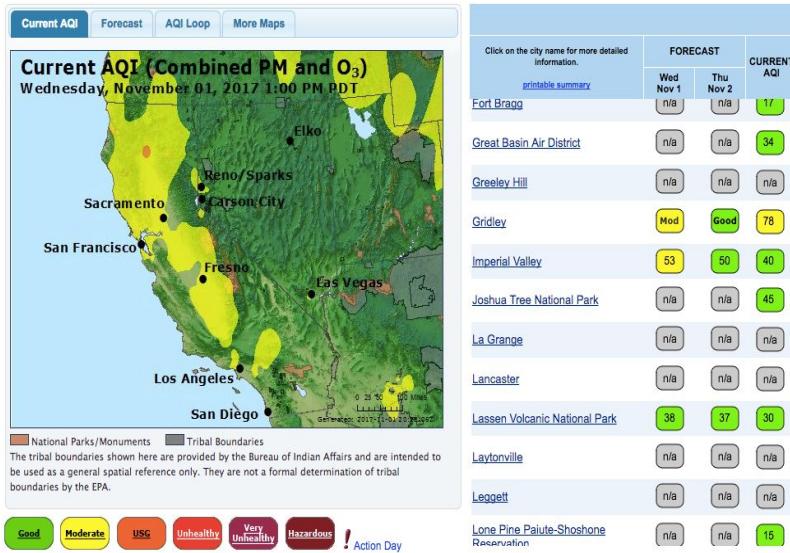


Figure 3.1.4 - Airnow

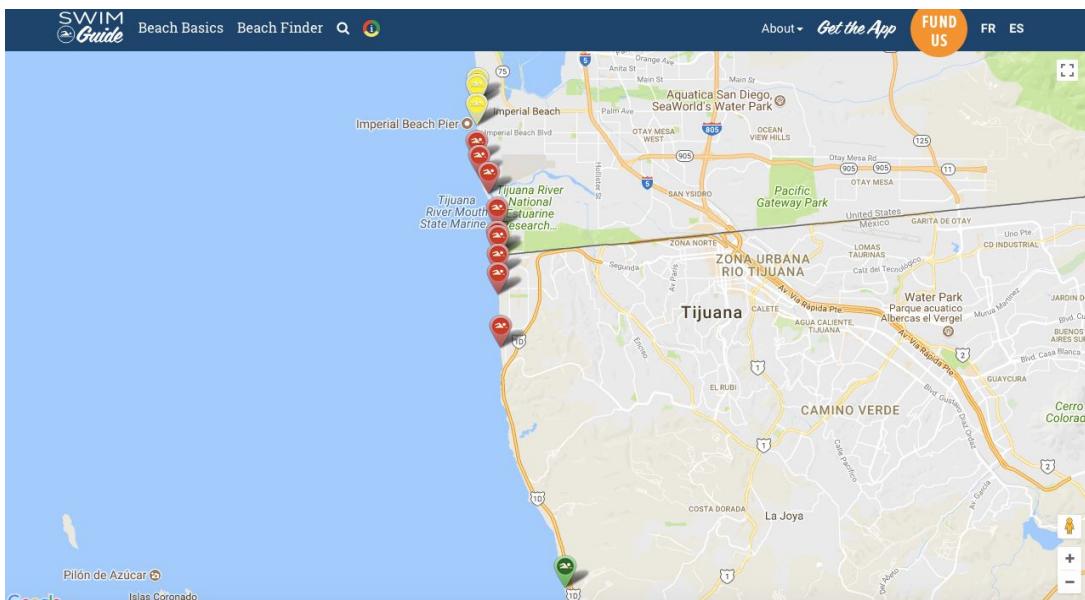


Figure 3.1.5 - Swim Guide